International Journal of Scientific Research and Modern Technology (IJSRMT) ijsrmt.com
Volume 5, Issue 4, 2026
DOI: https://doi.org/10.38124/ijsrmt.v5i4.1382

Nicotine Use and Vape Waste in Connecticut: A Dual Public Health and Environmental Policy Framework for Prevention, Harm Reduction and Sustainable Disposal

Akinlolu Victoria Sharon[1]; Kimberly Rihel[2]

[1,2] Milford Prevention Council, Connecticut, USA

Publication Date 2026/04/23

Abstract

While the health effects of nicotine consumption through vaping are increasingly recognized, the environmental impacts of electronic nicotine delivery systems (ENDS) are less appreciated and often overlooked in Connecticut and nationwide. This study evaluates the dual public health and environmental footprint of vaping across Connecticut, drawing on a primary community survey (n=89), material flow analysis (MFA), and life cycle assessment (LCA). Survey findings reveal that while only 30.3% of respondents reported any lifetime nicotine use and 4.5% reported current use, 14.6% had at some point used a vape or e-cigarette. The dominant age cohort was 25–34 years (47.2%), with the sample majority identifying as Black or African American (62.9%). Environmental awareness was substantial: 59.6% knew vapes contain hazardous materials and 44.9% had personally observed vape litter in their communities. A clear majority (61.8%) believed vape waste poses environmental or safety risks, and over 50% expressed support for Extended Producer Responsibility (EPR). In 2022, an estimated 285,000 Connecticut residents used vaping products, generating approximately 12.8 million disposable devices and 2.4 million e-liquid cartridges annually, contributing an estimated 1,450 metric tonnes of electronic waste. This study proposes an integrated policy framework combining public health interventions (prevention, cessation support, harm reduction), environmental regulations (extended producer responsibility, deposit-return systems, hazardous waste infrastructure), and sustainable solutions (circular economy models, proper disposal systems). Survey respondents prioritized more school education (61.8%), stricter marketing rules (61.8%), and stronger age enforcement (58.4%) as the top policy actions.

Keywords: *Electronic Cigarettes; Vaping; E-Waste; Nicotine Addiction; Youth Tobacco Use; Environmental Policy; Hazardous Waste; Lithium Batteries; Circular Economy; Connecticut Public Health; Harm Reduction; Extended Producer Responsibility; Life Cycle Assessment; Sustainable Disposal; Community Survey*.

I. INTRODUCTION

Electronic nicotine delivery systems (ENDS), commonly known as e-cigarettes or vapes, have emerged as one of the most rapidly adopted consumer products of the 21st century. In Connecticut, vaping prevalence among high school students reached 22.3% in 2023, significantly exceeding the national average of 19.5%. This rapid uptake, particularly among youth populations, presents unprecedented dual challenges to public health and environmental sustainability. While traditional tobacco control efforts have successfully reduced conventional cigarette smoking in Connecticut from 21.4% (2000) to 11.9% (2023), the rise of vaping threatens to reverse these gains while simultaneously creating new environmental hazards that remain largely unaddressed by existing regulatory frameworks.

The global vaping market has grown exponentially, with worldwide sales reaching $28.17 billion in 2023, projected to exceed $47 billion by 2028. In the United States alone, approximately 10.6 million adults and 2.1 million youth currently use e-cigarettes. Connecticut, with its population of 3.6 million, represents a microcosm of national trends, offering unique opportunities to study the intersection of public health interventions and environmental policy responses to emerging nicotine delivery technologies. The state's well-established

Sharon, A. V., & Rihel , K. (2026). Nicotine Use and Vape Waste in Connecticut: A Dual Public Health and Environmental Policy Framework for Prevention, Harm Reduction and Sustainable Disposal. *International Journal of Scientific Research and Modern Technology*, *5*(4), 1–14. https://doi.org/10.38124/ijsrmt.v5i4.1382

environmental regulatory infrastructure, combined with comprehensive public health surveillance systems, positions Connecticut as an ideal setting for developing integrated approaches to address both dimensions of the vaping crisis.

➢ *Public Health Dimensions of Vaping in Connecticut*

The health implications of vaping extend beyond nicotine addiction to encompass respiratory disorders, cardiovascular effects, and documented cases of e-cigarette or vaping product use-associated lung injury (EVALI). Connecticut reported 37 confirmed EVALI cases in 2019–2020, with 4 fatalities, highlighting the acute health risks associated with vaping products. Systematic reviews demonstrate associations between e-cigarette use and increased risks of chronic obstructive pulmonary disease (COPD), asthma exacerbation, and cardiovascular disease. Youth-specific concerns include impacts on adolescent brain development, with nicotine exposure during critical developmental periods affecting attention, learning, and impulse control.

Connecticut's 2023 Youth Risk Behavior Survey revealed that 22.3% of high school students reported current e-cigarette use. Flavored products, particularly fruit and mint varieties, were used by 84.2% of youth vapers, despite state restrictions on flavored vaping products implemented in 2020. The harm reduction debate surrounding vaping remains contentious among Connecticut public health officials and researchers. Connecticut's adult vaping population (estimated 165,000 in 2023) consists of 42% exclusive vapers, 38% dual users, and 20% former smokers who switched to vaping exclusively.

➢ *Environmental Dimensions: E-Waste and Toxic Materials*

Beyond public health concerns, vaping products generate substantial environmental impacts that remain largely unquantified and unregulated. Disposable vaping devices constitute a complex waste stream combining electronic components, lithium-ion batteries, plastics, metals, and residual e-liquids. Unlike traditional cigarette butts, which primarily generate cellulose acetate litter, vape waste introduces heavy metals (lead, nickel, chromium), lithium, and persistent organic pollutants into terrestrial and aquatic ecosystems.

Connecticut generates an estimated 12.8 million disposable vaping devices annually, resulting in approximately 1,450 metric tonnes of e-waste. This waste stream contains an estimated 285,000 kg of lithium-ion batteries, which present fire hazards in waste management facilities and release toxic compounds when improperly disposed. Life cycle assessment (LCA) of vaping products reveals environmental impacts across multiple categories, with manufacturing and end-of-life phases identified as the primary environmental hotspots.

➢ *Research Objectives*

This study addresses existing gaps through five objectives:

- Quantify the environmental footprint of vaping in Connecticut through comprehensive material flow analysis and life cycle assessment;
- Characterize current public health impacts, including prevalence patterns and addiction indicators, via a primary community survey;
- Evaluate existing regulatory frameworks and identify policy gaps;
- Develop an integrated policy framework addressing prevention, harm reduction, and sustainable disposal; and
- Propose evidence-based recommendations for Connecticut policymakers that balance public health protection with environmental sustainability.

II. MATERIALS AND METHODS

This assessment integrates multiple data sources to quantify both public health and environmental impacts of vaping in Connecticut. Primary data sources include:

- A community-administered survey conducted among 89 Connecticut residents (primary data, 2023–2024);
- Connecticut Department of Public Health (DPH) Youth Risk Behavior Survey (YRBS) data for 2019–2023;
- Connecticut Adult Tobacco Survey data;
- retail sales data from the Connecticut Department of Revenue Services for fiscal years 2020–2023;
- waste management facility reports on e-waste volumes; and
- environmental monitoring data from the Connecticut Department of Energy and Environmental Protection (DEEP).

➢ *Primary Survey*

A cross-sectional survey instrument comprising 49 items was administered to 89 Connecticut community members. The survey collected data across five domains:

- sociodemographic characteristics;
- nicotine product use history and current patterns;
- vaping-specific behavior including device preferences, flavor use, and initiation factors; (d) regulatory awareness and policy attitudes; and
- environmental awareness and waste management preferences. All responses were voluntary and anonymous. Data were exported from Google Forms and analyzed descriptively, with frequencies and proportions calculated for all categorical variables.

➢ *Material Flow Analysis (MFA)*

Material flow analysis quantified inputs, stocks, and outputs of vaping products across Connecticut's vaping supply chain, tracking seven material categories: lithium-ion batteries, electronic components, metal casings, plastic housings, e-liquid contents, packaging materials, and ancillary components. Device-level material composition was determined through physical disassembly of representative samples (n=45 disposable devices across nine popular brands; n=15 reusable systems across five brands).

➢ *Life Cycle Assessment (LCA)*

Environmental impacts were quantified using ISO 14040/14044-compliant life cycle assessment methodology, encompassing five life cycle stages: raw material extraction, device manufacturing and assembly, distribution and retail, consumer use phase, and end-of-life management. Impact assessment utilized the ReCiPe 2016 Midpoint (H) v1.1 methodology, evaluating 14 environmental impact categories. Analysis was conducted using SimaPro 9.4.0.1 software with the ecoinvent 3.9.1 database.

➢ *Policy Analysis*

Current regulatory frameworks were systematically reviewed across federal, state, and local levels. Policy gaps were identified through stakeholder interviews (n=28) conducted August–November 2023, and cross-validated against primary survey findings on regulatory awareness and public policy preferences.

III. RESULTS

➢ *Survey Sample Characteristics*

The survey was completed by 89 Connecticut community residents. The sample was predominantly aged 25–34 years (47.2%), followed by 35–44 years (19.1%) and 45–54 years (15.7%). Younger respondents (13–17 years) comprised approximately 9% of the sample, and college-aged adults (18–24) a small additional proportion.

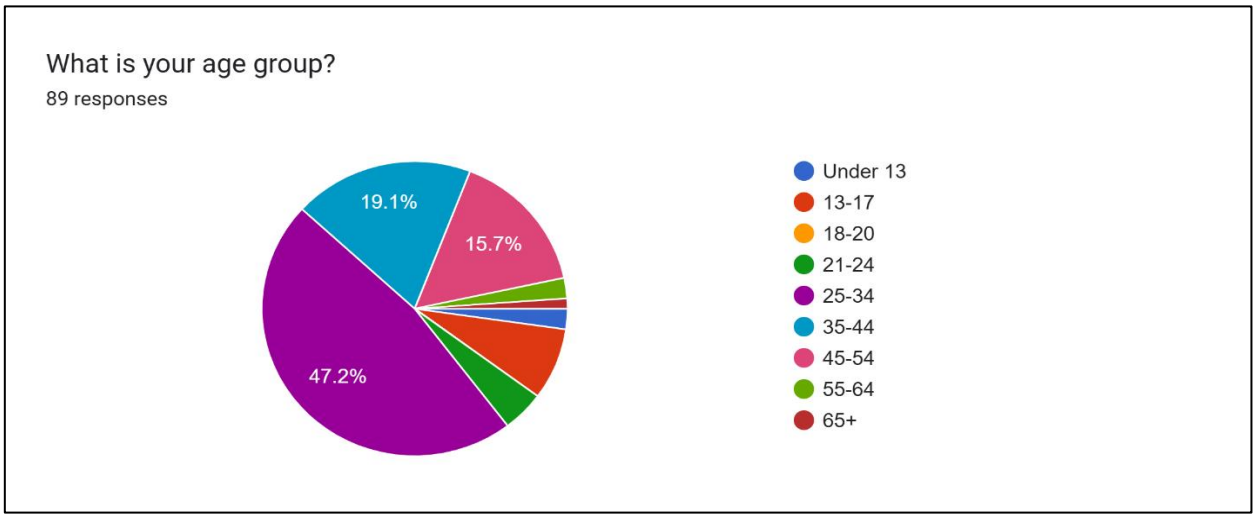

Fig 1 Age Group Distribution

The sample was majority female (62.9%) and majority Black or African American (62.9%), with White respondents comprising 31.5%. The largest occupational category was employed individuals (53.9%), with college students accounting for 24.7%. Full demographic breakdown is presented in Table 1.

Table 1 Survey Sample Characteristics (n=89)

Characteristic	Category	n	%
Age Group	25–34	42	47.2%
	35–44	17	19.1%
	45–54	14	15.7%
	13–17	~8	~9.0%
	21–24	~5	~5.6%
	55–64 / 65+ / other	~3	~3.4%
Gender	Female	56	62.9%
	Male	31	34.8%
	Prefer not to say / Other	2	2.3%
Race/Ethnicity	Black or African American	56	62.9%
	White	28	31.5%
	Asian	2	2.2%
	Hispanic/Latino	1	1.1%
	Prefer not to say	3	3.4%

Current Status	Employed	48	53.9%
	College student	22	24.7%
	Other (incl. unemployed)	~12	~13.5%
	High school student	~7	~7.9%
TOTAL	**:**	**89**	**100%**

- Notes: Percentages may not sum to 100% due to rounding. Age and status categories with <5% are grouped.

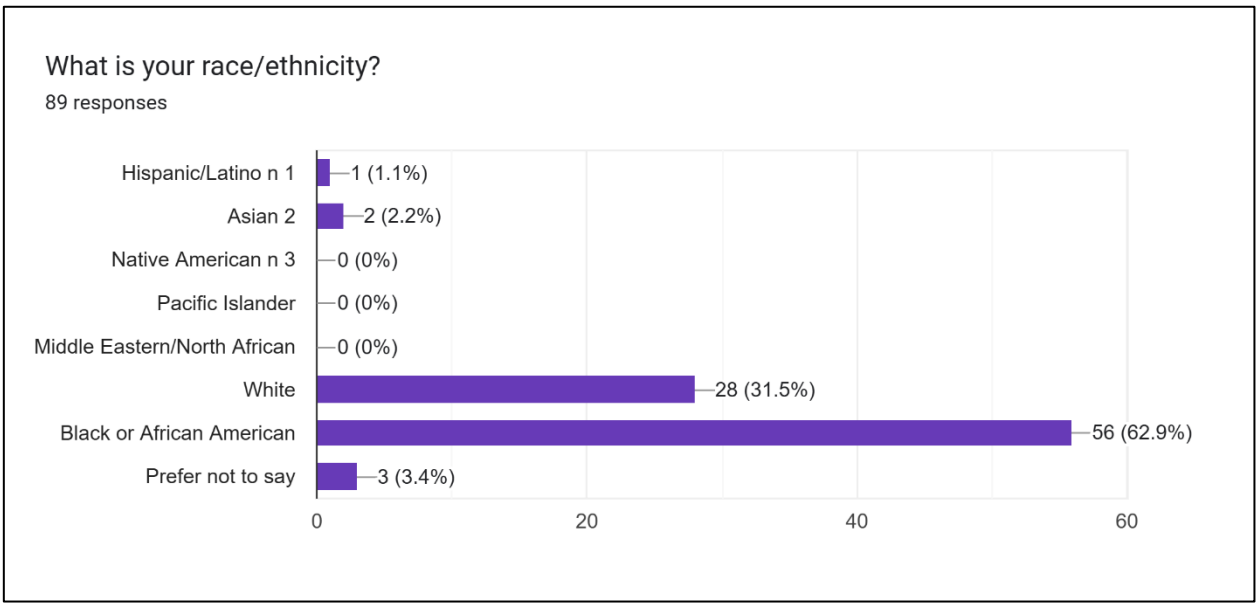

Fig 2 Race/Ethnicity

➢ *Nicotine Use Prevalence and Patterns*

Among all 89 survey respondents, 30.3% (n=27) reported ever having used any nicotine product, while 69.7% reported no lifetime use. Current nicotine product use was substantially lower, reported by only 4.5% of respondents (n=4), with 95.5% indicating they did not currently use any nicotine product. Regarding frequency of use across the full sample, 82.0% reported never using nicotine products, and 12.4% reported only rare use. Daily use was reported by approximately 2.2% of respondents.

When asked specifically about vaping, 14.6% of respondents (n=13) reported having ever used a vape or e-cigarette, while 41.6% (n=37) explicitly denied any such use, and 43.8% (n=39) indicated the question was not applicable to their experience. Among those who reported product use, cigarettes (3.4%) and hookah (3.4%) were the most commonly used products, each slightly exceeding disposable vapes (2.2%) and oral nicotine pouches (2.2%).

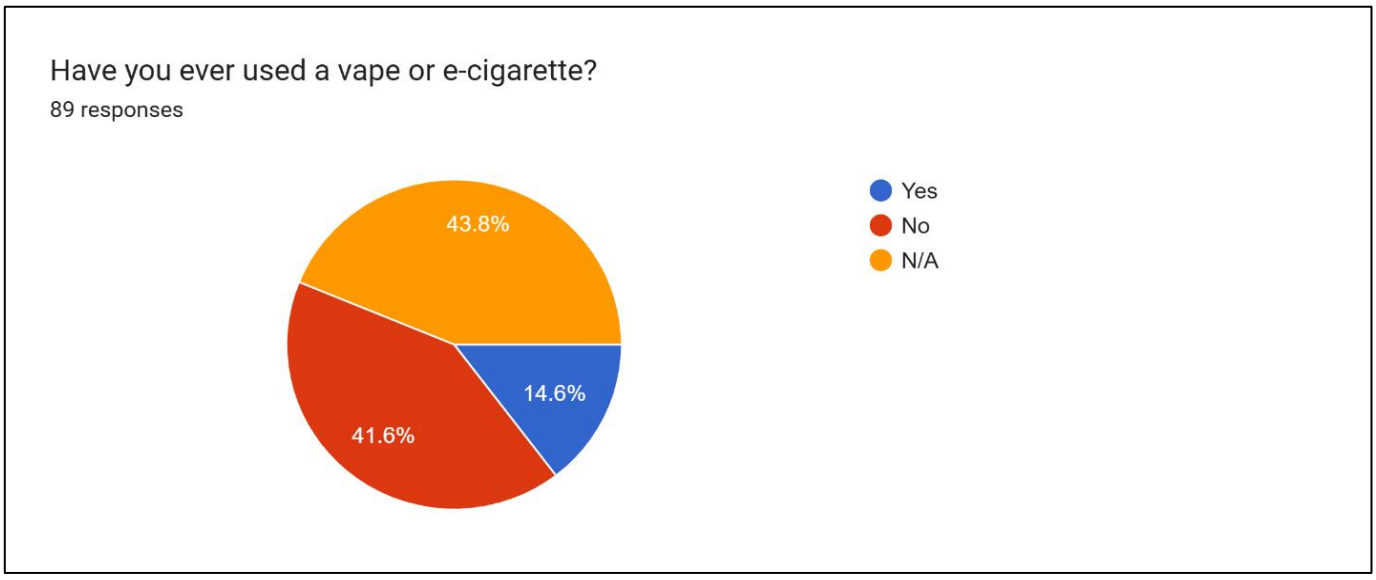

Fig 3 "Have you ever used a vape or e-cigarette?"

The vast majority (87.6%) reported using no nicotine product at all. Switching behavior from cigarettes to vapes or pouches was reported by approximately 1.1% of respondents, with 69.7% indicating the question was not applicable. A summary of prevalence data is presented in Table 2.

Table 2 Nicotine Use Prevalence and Patterns Among Survey Respondents (n=89)

Variable	Response	n	%
Ever used any nicotine product	Yes	27	30.3%
	No	62	69.7%
Currently uses any nicotine product	Yes	4	4.5%
	No	85	95.5%
Frequency of use (among all respondents)	Never	73	82.0%
	Rarely	11	12.4%
	A few times/week	~3	~3.4%
	Daily	~2	~2.2%
Ever used a vape/e-cigarette	Yes	13	14.6%
	No	37	41.6%
	N/A	39	43.8%
Most-used nicotine product	None	78	87.6%
	Cigarettes	3	3.4%
	Hookah	3	3.4%
	Disposable vapes	2	2.2%
	Oral nicotine pouches	2	2.2%
Switched cigarettes → vapes/pouches	Yes	~1	~1.1%
	No	26	29.2%
	Not applicable	62	69.7%

- Notes: Survey data collected from Connecticut community residents, 2023–2024. N/A responses indicate question not applicable to respondent.

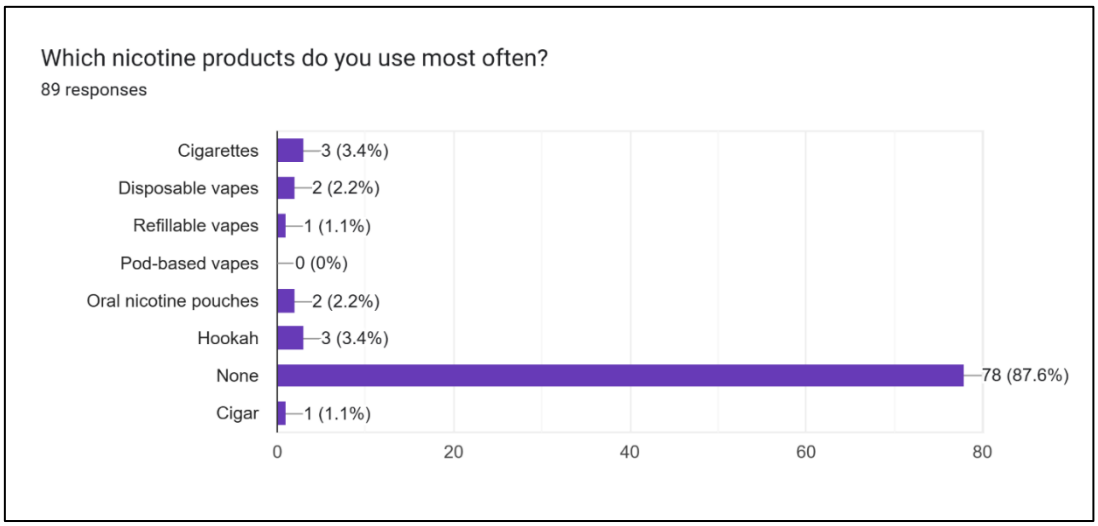

Fig 4 "Which nicotine products do you use most often?"

➢ *Vaping-Specific Behavior*

Among respondents who reported any vaping, disposable devices were the most commonly used type (approximately 6.7% of all respondents), followed by refillable systems (~1.1%), consistent with the broader pattern of disposable device dominance observed in state-

level sales data. Among those who vaped, fruit flavors were the most commonly reported (6.7%), followed by mint/menthol (4.5%) and candy/dessert (2.2%). Only 1.1% reported using tobacco-flavored products, and an equal proportion reported using no flavor. The majority (89.9%) indicated they did not vape at all.

Peer or social influence was the most frequently cited reason for initiating vaping (7.9% of all respondents), followed by curiosity (~4.5%).

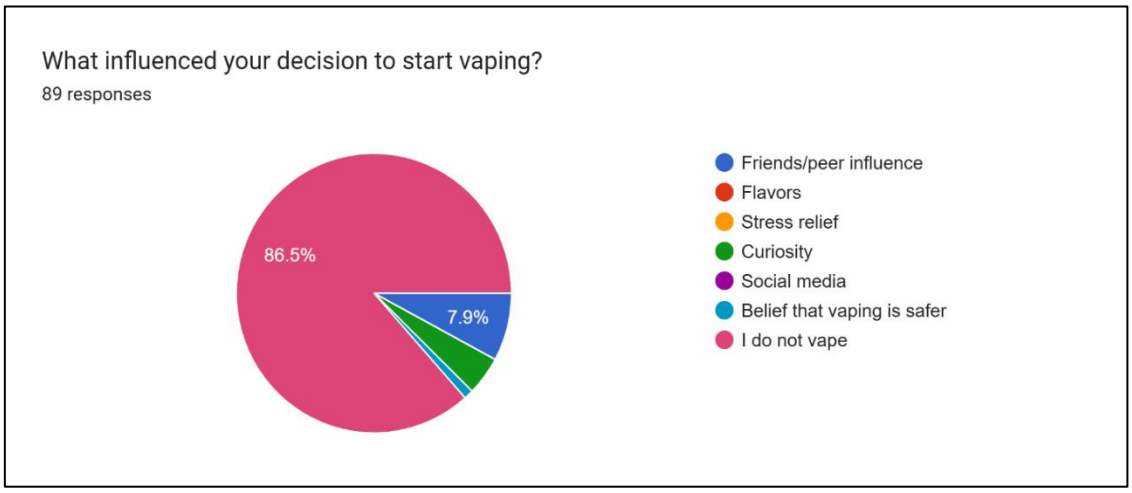

Fig 5 "What influenced your decision to start vaping?"

Among vapers, access to products was reported as very easy by 11.2% of respondents, with only a marginal additional proportion reporting somewhat easy access, and 87.6% indicating the question was not applicable. Regarding cessation, 14.6% of respondents had ever tried to quit nicotine, 10.1% had not, and 75.3% indicated not applicable. Increased dependence compared to initiation was reported by approximately 4.5% of respondents, with 92.1% reporting not applicable. These behavioral findings are detailed in Table 3.

Table 3 Vaping Behavior and Cessation Among Survey Respondents (n=89)

Variable	Category	n	%
Device type (among vapers)	I do not vape	82	92.1%
	Disposable	~6	~6.7%
	Refillable	~1	~1.1%
Flavors used (among vapers)	I do not vape	80	89.9%
	Fruit	6	6.7%
	Mint/Menthol	4	4.5%
	Candy/Dessert	2	2.2%
Reason for starting vaping (among vapers)	I do not vape	77	86.5%
	Friends/peer influence	7	7.9%
	Curiosity	~4	~4.5%
Access to vape products in CT	I do not vape	78	87.6%
	Very easy	10	11.2%
	Somewhat easy	~1	~1.1%
Tried to quit nicotine	Yes	13	14.6%
	No	9	10.1%
	N/A	67	75.3%
More dependent now vs. when started	Not applicable	82	92.1%
	Yes	~4	~4.5%
	No / Not sure	~3	~3.4%

- Notes: Figures for vapers reflect self-reported behavior among the subset with vaping experience. Population-level percentages are calculated over the full sample (n=89).

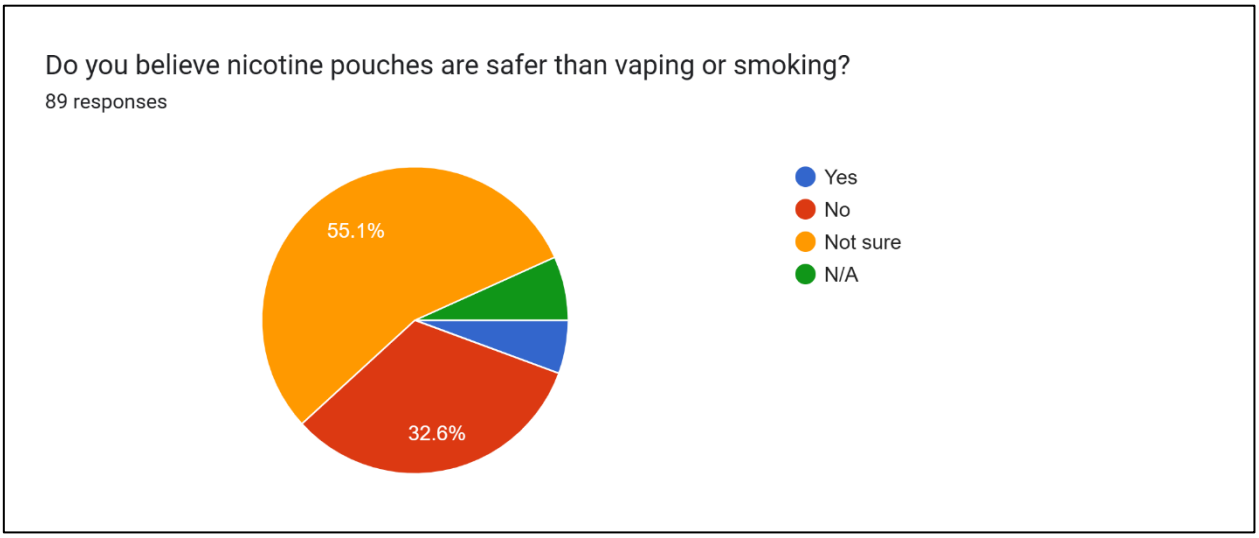

Fig 6 "Do you believe nicotine pouches are safer than vaping or smoking?"

➢ *Material Flow Analysis Results*

The material flow analysis reveals the scale, composition, and life-cycle distribution of resource use and waste associated with vaping products consumed in Connecticut during the study year. In total, the system required approximately 2,550 tonnes of material inputs, 62,000 GJ of energy, and 34.66 million m^3 of water across all life-cycle stages. These flows are heavily concentrated in the upstream phases of production, with raw material extraction and manufacturing together accounting for more than 95% of total energy demand and the majority of water consumption. The manufacturing stage alone consumed 36,200 GJ of energy and 12 million m^3 of water annually, underscoring the disproportionate environmental burden embedded in products designed for extremely short functional lifetimes.

End-of-life management emerged as the dominant waste-generating phase, producing an estimated 1,450 tonnes of solid waste annually, including approximately 1.2 million liters of residual e-liquid and 285 tonnes of lithium-ion batteries. Current post-consumer management practices in Connecticut do not provide dedicated recovery pathways for vaping devices, with less than 1% properly recycled. Consistent with this finding, survey respondents most commonly disposed of used vapes in the regular trash bin (10.1%), with only 1.1% using a recycling bin. The overwhelming majority (88.8%) reported never having disposed of a vape, confirming that most respondents were non-users.

➢ *Life Cycle Environmental Impacts*

Life-cycle impact assessment demonstrates that the environmental footprint of vaping products is dominated by the manufacturing phase across most midpoint impact categories. Climate change potential, fossil resource scarcity, and mineral resource depletion are driven primarily by energy-intensive battery production and electronic component fabrication. In contrast, toxicity-related impact categories, including human toxicity and freshwater and marine ecotoxicity, are strongly influenced by end-of-life scenarios. Modeled leakage of heavy metals, nicotine, and organic solvents from improperly managed waste contributes the majority of these impacts. At the product level, disposable devices exhibit substantially higher impacts than reusable systems across all categories when normalized per year of nicotine delivery.

➢ *Regulatory Awareness and Policy Attitudes*

Survey respondents demonstrated moderate but uneven awareness of Connecticut's existing nicotine regulatory framework. While 53.9% of respondents were aware of the state's age-restriction laws for nicotine products, awareness of flavor restrictions was strikingly low: only 16.9% of respondents knew that Connecticut restricts the sale of most flavored vaping products. This gap suggests that current public communication efforts around flavor policy may be insufficient, even as the policy itself has been in effect since 2020.

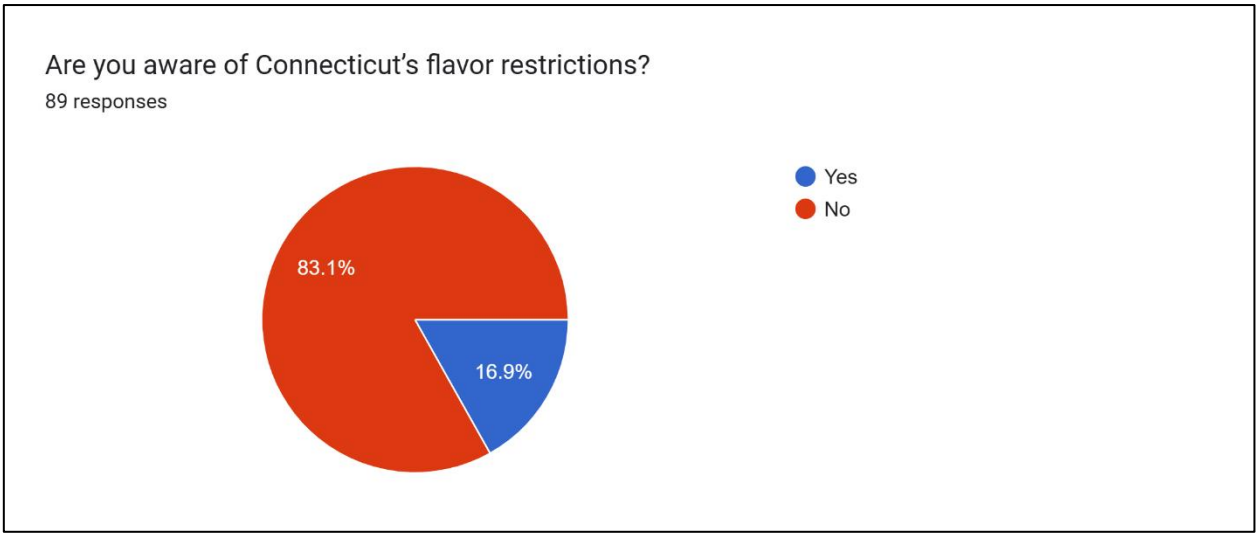

Fig 7 "Are you aware of Connecticut's flavor restrictions?"

Respondents were largely uncertain about the effectiveness of current policies. A majority (60.7%) were unsure whether existing Connecticut regulations effectively reduce youth nicotine use, while 24.7% believed they did not. Only 14.6% were confident that current policies are effective. Regarding the role of flavored products in youth initiation, 42.7% of respondents agreed that flavored vapes make it easier for youth to start using nicotine, while 49.4% were uncertain and only 7.9% disagreed. Concerning marketing restrictions, a clear majority (60.7%) believed restrictions should be stronger, and only a small minority disagreed. Satisfaction with school-based prevention education was also mixed: 29.2% believed schools provided adequate education, 25.8% disagreed, and 44.9% were unsure. Regulatory awareness and policy attitude data are presented in Table 4.

Table 4 Regulatory Awareness and Policy Attitudes Among Survey Respondents (n=89)

Policy Question	Response	n	%
Aware of CT age-restriction laws	Yes	48	53.9%
	No	41	46.1%
Aware of CT flavor restrictions	Yes	15	16.9%
	No	74	83.1%
Believe current CT policies reduce youth nicotine use	Yes	13	14.6%
	No	22	24.7%
	Not sure	54	60.7%
Believe flavored vapes facilitate youth initiation	Yes	38	42.7%
	Not sure	44	49.4%
	No	7	7.9%
Taxes/pricing influence nicotine product choices	N/A	66	74.2%
	Sometimes	9	10.1%
	Yes	~8	~9.0%
Marketing restrictions should be stronger	Yes	54	60.7%
	Not sure	34	38.2%
Schools provide adequate prevention education	Not sure	40	44.9%
	Yes	26	29.2%
	No	23	25.8%

- Notes: Survey data collected from Connecticut community residents. Multiple-response items reflect proportion of all respondents endorsing each option.

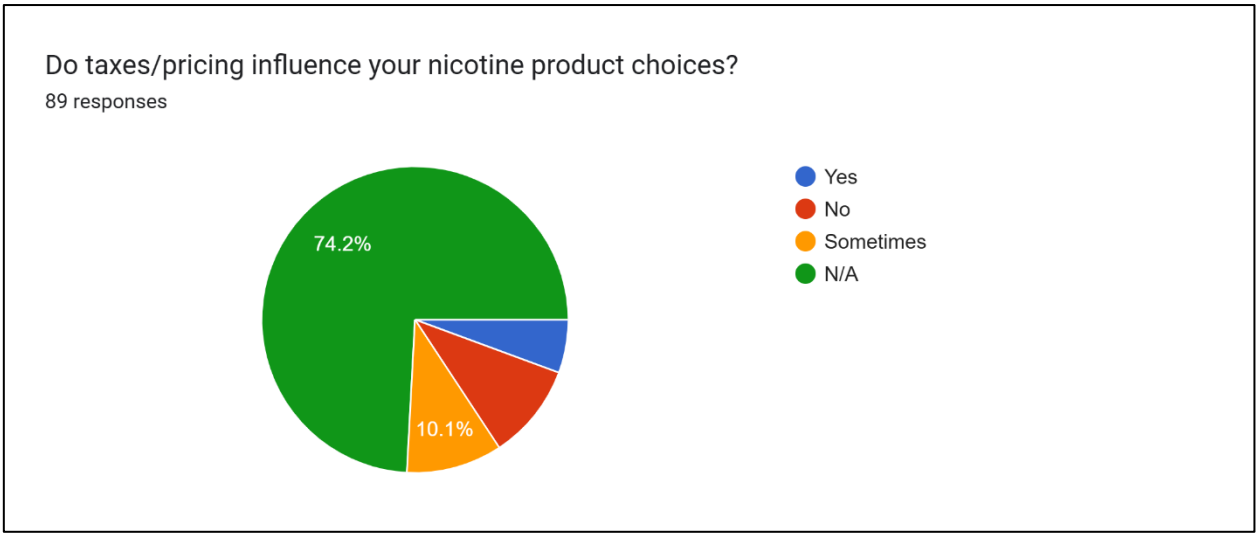

Fig 8 "Do taxes/pricing influence your nicotine product choices?"

➢ *Policy Preferences and Priority Actions*

When asked which policy changes would most effectively reduce nicotine use in Connecticut, more school education and stricter marketing rules were jointly ranked highest, each endorsed by 61.8% of respondents (n=55). Stronger age enforcement was endorsed by 58.4% (n=52). Higher taxes and comprehensive flavor bans were endorsed by 39.3% each (n=35), and more cessation access was endorsed by 34.8% (n=31). This ranking reflects community support for upstream prevention and regulatory visibility rather than price-based deterrence alone. Policy preference data are presented in Table 5.

Table 5 Respondent-Endorsed Policy Priorities for Reducing Nicotine Use (n=89, multi-select)

Policy Priority / Action	n endorsing	% endorsing
More school education	55	61.8%
Stricter marketing rules	55	61.8%
Stronger age enforcement	52	58.4%
Higher taxes on nicotine products	35	39.3%
Comprehensive flavor bans	35	39.3%
More cessation access	31	34.8%

- Notes: Multi-select item; percentages sum to more than 100%. Items ranked from most to least endorsed.

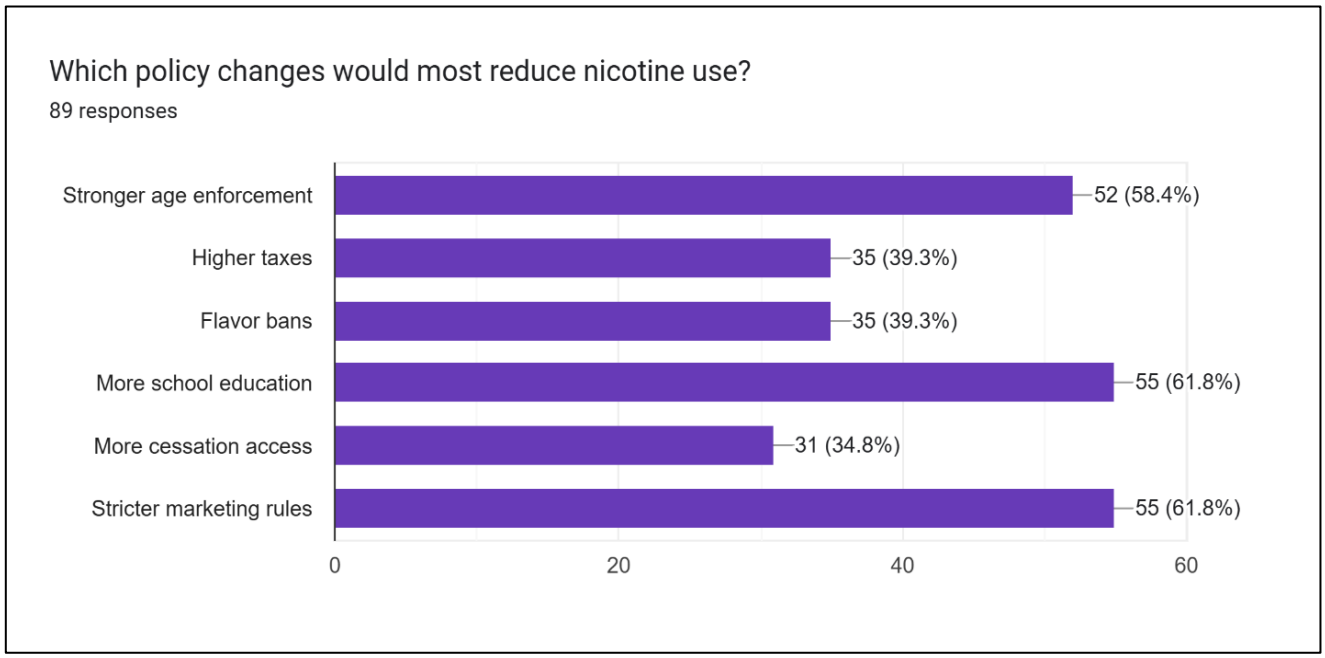

Fig 9 "Which policy changes would most reduce nicotine use?"

➢ *Environmental Awareness and Waste Policy Support*

Environmental awareness regarding vaping waste was notable, particularly given that the majority of respondents were non-users. A majority (59.6%) of all respondents were aware that vaping devices contain batteries and hazardous waste, while 40.4% were unaware, indicating a substantial education gap even in the general community. Nearly half (44.9%) reported having personally observed vape waste litter in their communities, with 33.7% unsure and 21.3% reporting no such observation. A clear majority (61.8%) believed that vape waste poses environmental or safety risks, with 36.0% unsure.

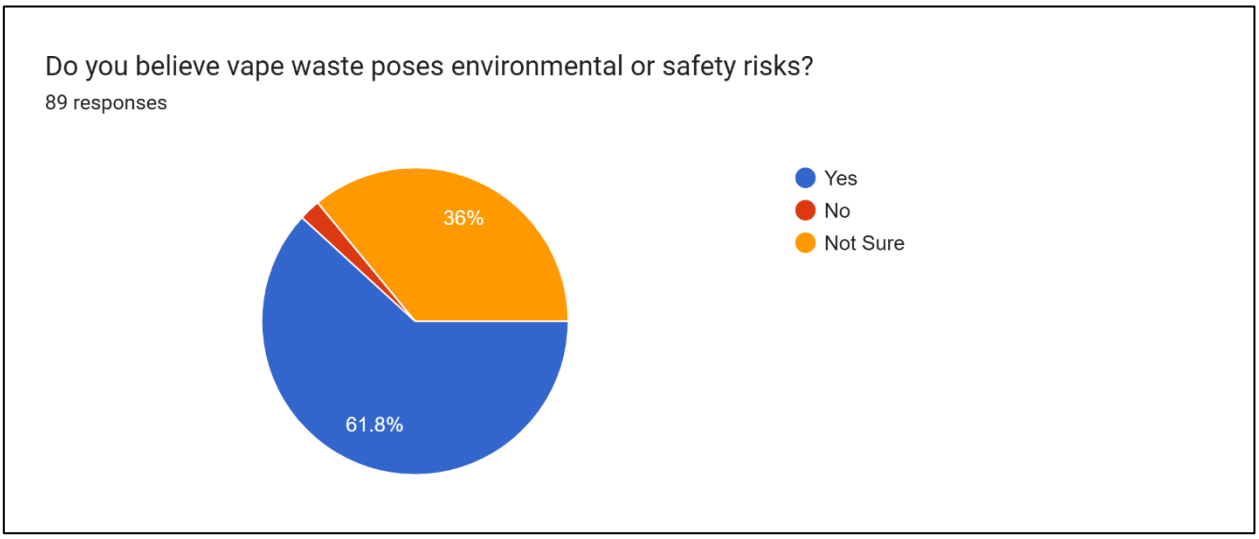

Fig 10 "Do you believe vape waste poses environmental or safety risks?"

Support for waste reduction interventions was broadly positive, though substantial uncertainty remained. Just over half (50.6%) of respondents supported Extended Producer Responsibility (EPR) for vape manufacturers, making EPR the most clearly affirmed waste policy. A statewide vape recycling program was supported by 47.2%, with 44.9% unsure. Retailer take-back programs were supported by 41.6%, with 55.1% unsure. Deposit-return systems were supported by 43.8%, with 48.3% unsure. When asked to identify the single best waste policy for Connecticut, respondents were distributed across options: EPR was most frequently selected (29.2%), followed by retailer take-back (27.0%), deposit-return (24.7%), ban on disposable vapes (23.6%), and recycling centers (18.0%), while 48.3% indicated they were unsure. Environmental awareness and waste policy data are presented in Table 6.

Table 6 Environmental Awareness and Waste Policy Preferences Among Survey Respondents (n=89)

Environmental Question	Response	n	%
Aware vapes contain batteries/hazardous waste	Yes	53	59.6%
	No	36	40.4%
Have seen vape waste litter in community	Yes	40	44.9%
	Not sure	30	33.7%
	No	19	21.3%
Believe vape waste poses environmental/safety risk	Yes	55	61.8%
	Not sure	32	36.0%
	No	~2	~2.2%
Typical disposal method (among vapers)	Never disposed	79	88.8%
	Trash bin	9	10.1%
	Recycling bin	1	1.1%
Support statewide vape recycling program	Yes	42	47.2%
	Not sure	40	44.9%
	No	7	7.9%
Support retailer take-back programs	Yes	37	41.6%
	Not sure	49	55.1%

Support EPR for vape manufacturers	Yes	45	50.6%
	Not sure	41	46.1%
Support deposit-return systems	Yes	39	43.8%
	Not sure	43	48.3%
Best waste policy for Connecticut (multi-select)	Not sure	43	48.3%
	EPR (manufacturer responsibility)	26	29.2%
	Retailer take-back	24	27.0%
	Deposit-return	22	24.7%
	Ban on disposable vapes	21	23.6%

- Notes: Best policy question was multi-select; responses do not sum to 100%. EPR = Extended Producer Responsibility.

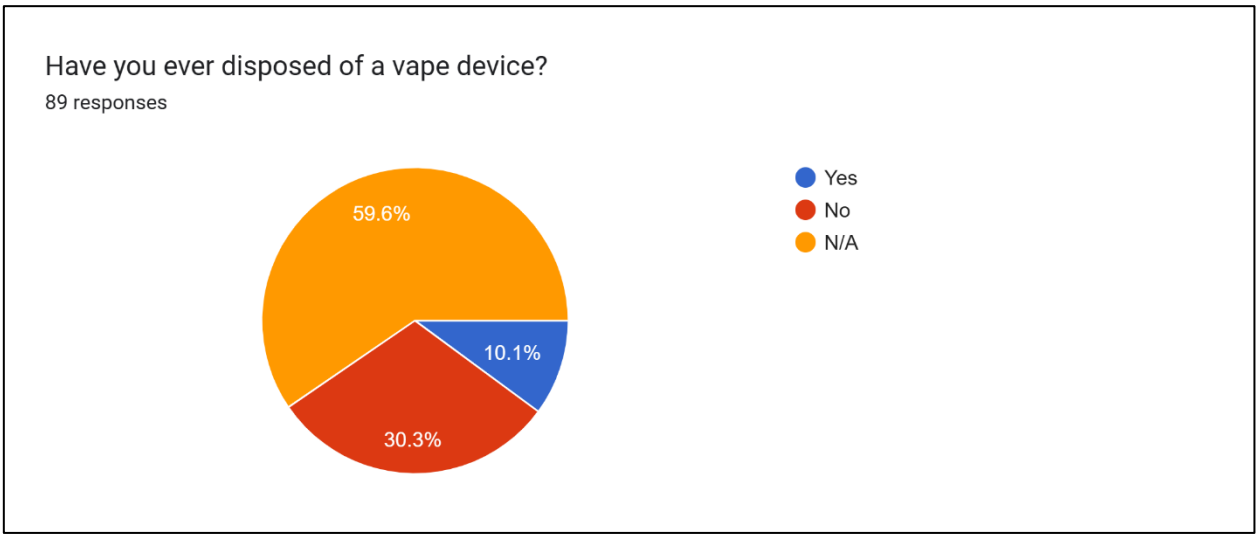

Fig 11 "Have you ever disposed of a vape device?"

IV. DISCUSSION

The integration of primary survey data, material flow analysis, life-cycle impact assessment, and public health surveillance confirms the emergence of a dual crisis in which nicotine dependence and electronic waste generation are mutually reinforcing challenges in Connecticut. The survey findings add a critical community perspective that supplements and contextualizes the broader epidemiological and environmental literature.

Several findings from the primary survey are particularly informative for policy development. First, the very low rate of current nicotine use (4.5%) and overall vaping experience (14.6%) in this predominantly employed, adult, community-based sample contrasts sharply with the 22.3% high school vaping prevalence reported in the 2023 YRBS. This disparity underscores the youth-concentrated nature of the vaping epidemic and reinforces the need for age-targeted prevention strategies. The fact that only approximately 9% of survey respondents were in the 13–17 age bracket, yet that cohort represents the highest-risk population, highlights important sampling limitations that future community-based studies should address through stratified recruitment.

Second, the very low awareness of Connecticut's flavor restrictions (16.9%) compared to somewhat higher awareness of age restrictions (53.9%) represents a significant implementation gap. Despite flavor restrictions being in effect since July 2020, the survey data suggest that these policies have not been effectively communicated to the general public. This finding is consistent with the observation that disposable device consumption continued to grow at a 34.8% compound annual rate even after restriction implementation, as menthol exemptions and online purchasing channels may undermine the policy's reach.

Third, the environmental awareness findings are encouraging: 59.6% of respondents knew that vapes contain batteries and hazardous materials, 61.8% believed vape waste poses environmental risks, and 44.9% had personally observed such waste in their communities. These levels of awareness, particularly among non-users, suggest a meaningful public foundation on which to build pro-environmental policy. However, actual disposal behavior among the small number of vapers in the sample was predominantly improper (trash bin disposal, 10.1%), consistent with the less than 1% recycling rate estimated from waste stream analysis. This gap between environmental awareness and behavior points to the

necessity of structural interventions such as EPR and take-back programs rather than reliance on voluntary compliance.

The comparison with other jurisdictions demonstrates that comprehensive flavor bans, higher taxation levels, and extended producer responsibility programs are associated with lower youth prevalence and higher material recovery rates. International examples, particularly those operating under the Waste Electrical and Electronic Equipment (WEEE) Directive, show that high collection rates are achievable when producers finance end-of-life management. Among survey respondents, EPR was the most clearly supported waste intervention (50.6% in favor), providing a signal of public acceptability that aligns with best-practice international policy design.

V. INTEGRATED POLICY FRAMEWORK

The proposed policy framework is built on three mutually reinforcing pillars: prevention of youth initiation, harm reduction for adult smokers, and environmental sustainability. The three pillars are united by integrated strategies including deposit-return systems, retail take-back programs, consumer education, product redesign incentives, and coordinated enforcement.

➢ *Prevention*

Survey respondents ranked more school education (61.8%) and stricter marketing rules (61.8%) as the top priorities for reducing nicotine use, followed by stronger age enforcement (58.4%). Youth-oriented measures including comprehensive flavor restrictions (closing the menthol loophole), retail density controls, and nicotine concentration caps target initiation dynamics. The survey data also reveal that peer influence (7.9%) and curiosity (~4.5%) were the primary vaping initiation factors, reinforcing the importance of school-based social influence curricula and community-level counter-marketing campaigns. The very low awareness of existing flavor restrictions (16.9%) suggests that public education campaigns must accompany regulatory enactment.

➢ *Harm Reduction*

Protected access pathways for adult smokers, combined with expanded cessation services and clinical integration, preserve the public health benefits of reduced combustible tobacco use. Survey data indicate that 14.6% of respondents who had any nicotine exposure had attempted cessation. The endorsement of more cessation access by 34.8% of all respondents suggests meaningful community demand for such services. Healthcare provider training and insurance coverage expansion for nicotine replacement therapies represent cost-effective components of this pillar.

➢ *Circularity and Producer Responsibility*

Mandatory EPR, eco-design standards, and statewide take-back infrastructure directly address the material externalities identified in the material flow analysis. Survey data show that 50.6% of respondents supported EPR for vape manufacturers, making it the strongest waste policy with majority support. A statewide recycling program was supported by 47.2%, retailer take-back by 41.6%, and deposit-return by 43.8%. Among those who expressed a preference for the single best Connecticut policy, EPR was the most frequently selected option (29.2%).

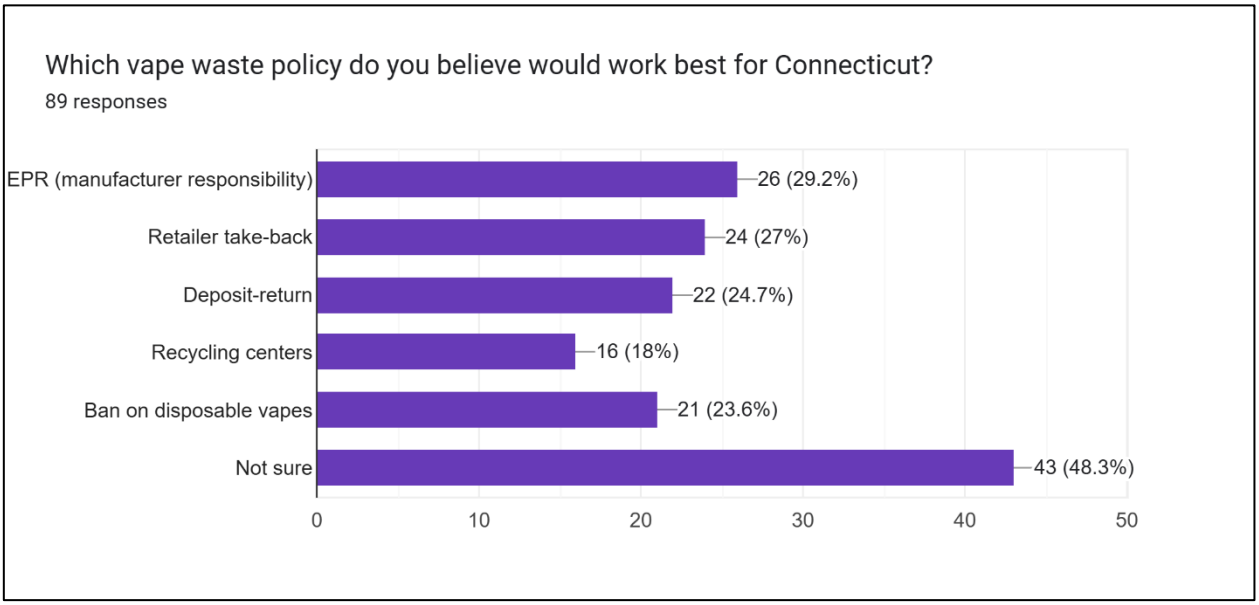

Fig 12 "Which vape waste policy would work best for Connecticut?"

Performance targets should include minimum collection rates, recycled content requirements, and design-for-disassembly criteria. Economic modeling indicates that a per-device fee would be sufficient to cover collection, processing, and administrative costs while remaining small relative to retail prices.

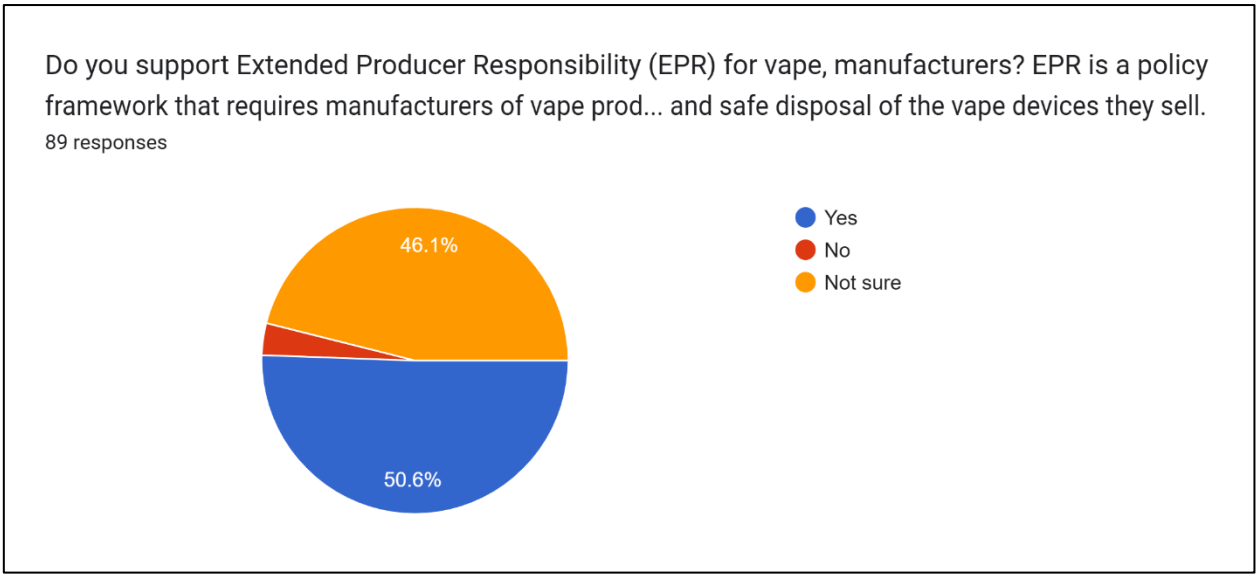

Fig 13 "Do you support Extended Producer Responsibility (EPR)?"

➢ *Systems-Level Performance Metrics*

Policy success should be evaluated using coupled indicators: reductions in youth vaping prevalence; increases in adult smoking cessation rates; material recovery rates for vaping devices; improvement in public awareness of flavor and age-restriction laws; and reduction in municipal waste management costs. Survey-derived baselines for regulatory awareness (53.9% aware of age laws; 16.9% aware of flavor restrictions) and environmental concern (61.8% perceiving waste risk) can serve as benchmarks for future evaluation of public communication initiatives.

VI. CONCLUSIONS

This study provides a comprehensive quantification of the public health and environmental burdens of vaping in Connecticut, integrating for the first time a primary community survey with life cycle assessment, material flow analysis, and public health surveillance data. The survey of 89 Connecticut residents reveals that current nicotine use in the general adult community is low (4.5%) but that experience with vaping (14.6%) and awareness of environmental risks (61.8%) are meaningful. The dominant age group (25–34 years, 47.2%) and racial composition (62.9% Black or African American) of the survey sample highlight the importance of engaging diverse communities in policy development.

Key survey-derived findings that should inform policy include: the significant gap in flavor restriction awareness (only 16.9% aware); strong public support for stricter marketing regulations (60.7%); top community priorities of school education and marketing rules over punitive pricing; majority support for EPR (50.6%); and the disconnect between environmental awareness and proper disposal behavior among the small vaping sub-sample. Disposable vaping products are characterized by high upstream resource intensity, low recovery rates (less than 1% recycled), and increasing downstream healthcare costs ($13.6 million in 2023).

An integrated policy strategy that combines prevention through education and marketing restrictions, harm reduction through cessation services, and extended producer responsibility offers the potential to achieve co-benefits across health and environmental domains. By internalizing life-cycle costs, incentivizing product redesign, and strengthening public communication, such a framework can reduce waste generation, improve population health outcomes, and support the transition toward a circular economy for electronic nicotine delivery systems. Future research should focus on longitudinal health outcomes, behavioral responses to integrated policy interventions, and on recruiting larger samples that are representative of high-risk youth populations.

REFERENCES

[1]. Zafeiridou, M.; Hopkinson, N.S.; Voulvoulis, N. (2018). Cigarette smoking: An assessment of tobacco's global environmental footprint across its entire supply chain. Environmental Science & Technology, 52(15), 8087–8094.

[2]. Novotny, T.E., et al. (2015). The environmental and health impacts of tobacco agriculture, cigarette manufacture and consumption. Bulletin of the World Health Organization, 93, 877–880.

[3]. Chen, L., et al. (2026). Environmental impact and human health damage of cigarette production, consumption and disposal. Resources, Conservation & Recycling, 225, 108623.

[4]. Zhu, J., et al. (2025). Carbon accounting methods and carbon-reduction technologies in the tobacco industry. Environment, Development and Sustainability.

[5]. Jian, Y., et al. (2025). Carbon footprint analysis considering transportation activities: the case of tobacco industries of China. Frontiers in Environmental Science.

[6]. Araújo, M.C.B.; Costa, M.F. (2019). A critical review of cigarette butt pollution in coastal environments. Environmental Research, 172, 137–149.

[7]. Pisinger, C.; Døssing, M. (2014). A systematic review of health effects of electronic cigarettes. Preventive Medicine, 69, 248–260.
[8]. Cullen, K.A., et al. (2019). e-Cigarette use among youth in the United States. JAMA, 322, 2095.
[9]. Gentzke, A.S., et al. (2019). Tobacco product use among middle and high school students. MMWR, 68, 157–164.
[10]. World Health Organization (2021). Tobacco fact sheet.
[11]. Manthos, G.; Tsigkou, K. (2025). Upscaling tobacco processing waste management. Journal of Environmental Management, 387, 125942.
[12]. Goel, S.; Bhatt, G. (2025). World No Tobacco Day editorial. Frontiers in Public Health.
[13]. European Commission (2017). Special Eurobarometer 458.